AD NUMBER
AD301849
CLASSIFICATION CHANGES
TO: unclassified
FROM: confidential
LIMITATION CHANGES
TO: Approved for public release, distribution unlimited
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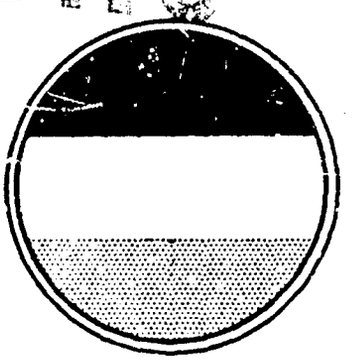
UNITED STATES ARMY INFANTRY BOARD

FORT BENNING, GEORGIA

REPORT OF PROJECT



PROJECT NR 2751 (Temperate) **DATE** 19 March 1958

SERVICE TEST OF FUZE, GRENADE, HAND, T101LE1 (DA PROJECT NR 505-04-001)

TABLE OF CONTENTS ATTACHED AS A FOLD-OUT TO BACK COVER

USA INF BD
FORM 1, 1 FEB 57

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UNITED STATES ARMY INFANTRY BOARD
Fort Benning, Georgia

REPORT OF TEST PROJECT NR 2751 (TEMPERATE)
SERVICE TEST OF FUZE, GRENADE, HAND, T1011E1
(DA PROJECT 505-04-001) (U)

19 March 1958

1. AUTHORITY.

a. Directive.--Ltr, ATDEV-3 471/51 (C) (27 May 57), Hq USCONARC, 27 May 57, subject: "Service Test of Fuze, Grenade, Hand, T1011E1 (U)," as amended by Ltr, ATDEV-3 471/51 (C) (27 May 57), Hq USCONARC, 20 Jun 57, subject: "Service Test of Fuze, Grenade, Hand, T1011E1 (U)."

b. Purpose.--To determine the suitability of the Fuze, Grenade, Hand, T1011E1, assembled in the Grenade, Hand, Fragmentation, M26A1 (Modified), for Army use.

c. Scope.--This project includes a temperate phase, conducted by the United States Army Infantry Board, and an arctic phase, conducted by the United States Army Arctic Test Board, Fort Greely, Alaska.

2. REFERENCES.--(See Appendix IV.)

3. DESCRIPTION OF MATERIEL.

a. Test Item.--The Fuze, Grenade, Hand, T1011E1, hereinafter referred to as the test item, is a time fuze consisting of a fuze body made of a one-piece casting which contains a pyrotechnic delay charge, primer, striker assembly, pull-ring assembly and safety lever, and a detonator case, containing a detonator. The detonator case is crimped to the fuze body. The test item is designed to cause detonation in approximately 4.5 seconds after ignition of the primer. The test item is similar to the M204A2 fuze; the most significant differences are that the test item has a more powerful detonator and a shorter detonator case of larger diameter. The fuze well of the M26A1 hand grenade, in which the test item is assembled, has been modified by replacing its standard fuze holder with one that is greater in diameter and shorter in length than that of the unmodified M26A1 grenade.

b. Control Item.--The Fuze, Grenade, Hand, M204A2, hereinafter referred to as the control item, assembled in the Grenade, Hand, Fragmentation, M26A1, is the current standard hand grenade fuze and is described in reference 4, appendix IV.

4. BACKGROUND.

a. In May 1946, the War Department Equipment Board established a requirement for an improved fragmentation hand grenade with a selective time-impact fuse. The military characteristics for fragmentation hand

[redacted]

grenades, which include a time-impact fuze, were established in 1953 (ref 3, app IV). The Army Equipment Development Guide in 1954 reiterated a requirement for a time-impact fuze but stated that as an interim measure an improved time fuze was required (ref 6, app IV). In February 1954, the M204A2 fuze was classified as standard type for use with the M26 hand grenade (ref 4, app IV).

b. In order for the M204A2 fuze to function effectively with the M26 grenades, it was necessary to place a booster charge around the fuze holder assembly within the grenade. This restricted the grenade loading hole area to such an extent that when the grenade was loaded by mass production methods excessive cavitation in the bursting charge resulted. In addition, omission through error of the pellets composing the booster charge resulted in erratic functioning of the grenade. A uniform fuze burning time was not always attained with the M204A2 fuze. To correct these deficiencies, the T101lE1 fuze was designed. This fuze was provided with a more powerful detonator, which eliminated the need of booster charges and insured more positive functioning of the grenade. The elimination of the booster charges also permitted better loading of the grenade's bursting charge. It was expected that a more uniform fuze burning time would be obtained with the T101lE1 fuze (ref [illegible], app IV). Partial results of engineering tests are available (ref 11, app IV).

c. Test item is proposed for Tripartite Standardization and is entered on Integrated List Sheet 1-1-4-1.

5. SUMMARY OF TESTS.

a. The test and control items were subjected to the following tests: Physical Characteristics, Safety, Fuze Functioning, Fragmentation, and Lethality, Hot and Cold Chamber, Adverse Conditions, Rifle Projection, Hand Throwing, Suitability for Parachute Delivery, Reliability, and Comparison with Military Characteristics (see app I).

b. When the coordinated plan of test for the conduct of this project was submitted for approval, and subsequent to the completion of scheduled tests, USCONARC directed that (ref 13, app IV):

(1) Malfunctions, occurring as a result of tests involving activation of grenades under water and in mud, not be used as a basis of determining the suitability of the test item.

(2) Rifle projection tests not be conducted due to the elimination of this capability in future rifles.

(3) Cold chamber test be conducted at a temperature of -25°F.

[redacted]

(4) Further tests be conducted by hand throwing the grenade into mud and water and against various types of ground surfaces to determine the reliability of the test item in the hand thrown role.

c. This Board did not consider the results obtained in tests enumerated in 5b(1) and (2), above, in determining the suitability of the test item for Army use. Additional tests were devised and conducted in accordance with paragraph 5b(4), above, and results obtained were considered in determining the suitability of the test item.

d. Results.

(1) The test and control items are of the same weight and their method of operation is identical.

(2) The test and control items are comparable in safety features, effectiveness of fuze functioning, effect upon fragmentation and lethality of the M26A1 Hand Grenade, functioning after hot and cold chamber conditioning, functioning after adverse conditions storage, throwing characteristics, effectiveness after aerial delivery and in overall reliability.

(3) The average fuze burning time for the test and control items after subjection to cold storage for 72 hours was 5.3 seconds. Following three days immersion in salt water and exposure in open storage for three weeks, the average fuze burning time for the test and control items was 4.9 seconds. These averages exceed the 4.3 second, ± .3 second, specified by the military characteristics. However, this variation is considered acceptable (see Tests Nr 5 and 6, app I).

(4) When stored under adverse conditions, there were three instances in which the test and control items became loose in the grenade assembly and failed to function when hand thrown. A similar deficiency was reported in the service test of the M204A2 fuze (see Test Nr 6, app I and ref 10, app IV).

6. CONCLUSIONS.--The United States Army Infantry Board concludes that:

a. The Fuze, Grenade, Hand, T101lE1, assembled in the Grenade, Hand, Fragmentation, M26A1 (Modified) is suitable for Army use in the temperate zone.

b. Correction of the minor deficiencies will render the item more suitable for Army use (app II).

7. RECOMMENDATIONS.--It is recommended that:

a. Contingent upon determination of suitability for Arctic use, the Fuze, Grenade, Hand, T1011E1, be adopted for Army use with the Grenade, Hand, Fragmentation, M26A1 (Modified) and classified as standard type.

b. The Fuze, Grenade, Hand, T1011E1, with Grenade, Hand, Fragmentation, M26A1 (Modified) be further modified to correct deficiencies listed in Appendix II.

c. This Board be furnished one hundred (100) each of the initial production lot of the modified Fuze, Grenade, Hand, Fragmentation, M26A1 (Modified) for confirmatory test.

HENRY B. KUNZIG
Colonel, Infantry
President

Appendixes:
I Details of Test
II Deficiencies and Suggested Modifications
III Photographs
IV References

APPENDIX I - DETAILS OF TESTS

Report of Project Nr 2751

Test Nr 1, PHYSICAL CHARACTERISTICS.

1. PURPOSE.--To determine and compare the physical characteristics of the test and control items.

2. METHOD.

a. Test and control items were photographed (see app III-1), weighed, measured and average size and weight computed.

b. Drawings of test and control items and notes on materiel provided by Ordnance were studied to determine their operational characteristics.

3. RESULTS.

	T1011E1	M204A2
a. Weights (ounces)		
(1) Fuze	2.5	2.5
(2) Fuzed M26A1 Grenade	16	16
b. Dimensions (inches)		
(1) Overall length	2-12/16	3-12/16
(2) From base of bouchon to bottom of detonator case	1-14/16	2-14/16
(3) Diameter of detonator case	6/16	5/16

c. The test and control items are assembled in the M26A1 Fragmentation Hand Grenade with fiber washers as the only sealant between the bouchon and the grenade body.

d. The external appearance of grenades containing test and control fuzes is identical (see app III-1).

Test Nr 2, SAFETY

1. PURPOSE.--To determine and compare the effectiveness of the safety features of the test and control items.

2. METHOD.

a. Five each, test and control items, assembled in inert M26A1 grenades, were armed and hand thrown in the normal manner. The average time between release of the grenade safety lever and detonation of the test and control items was computed and recorded.

b. Five each, test and control items, assembled in inert M26A1 grenades, were rifle projected from an M-1 rifle, using the M7A3 Rifle Grenade Launcher, M1A2 Projection Adapter, and Rifle Grenade Cartridges, Caliber .30, M3. The average time between projection and detonation of the test and control items was computed and recorded.

c. Three stop watches were used to determine the average times in a and b, above.

d. The effectiveness of the safety pin as a safety feature was noted in all tests.

3. RESULTS.

a. Average time between release of grenade safety lever and detonation when hand thrown (time in seconds):

	Test	Control
(1) Maximum	4.7	4.6
(2) Minimum	4.3	4.4
(3) Average	4.6	4.5

b. Average time between projection of the grenade and detonation when rifle projected (time in seconds):

	Test	Control
(1) Maximum	5.1	5.1
(2) Minimum	4.7	4.7
(3) Average	4.9	4.8

c. When rifle projected, the arming clip of the Projection Adapter, M1A2, was effective in holding the safety lever of both test and control items in place after removal of the safety pin. (A previously reported deficiency with the M204A2 Fuze, ref 10, app IV) When the safety pin of the grenade was removed, there was a very slight upward movement of the safety lever under pressure of the striker and striker spring (see app III-2).

d. The safety pin functioned effectively in all tests of both test and control items.

4. ANALYSIS.--The safety features (time of detonation after arming and safety pin functioning) of the test and control items are equally effective.

Test Nr 3, FUZE FUNCTIONING.

1. PURPOSE.--To determine and compare the adequacy of the functioning of the test and control items.

2. METHOD.

a. Five each, test and control items assembled to M26A1 grenades were subjected to the following conditions and detonated:

(1) Submerged in muddy water for 30 minutes, allowed to dry for 24 hours, armed and hand thrown.

(2) Armed and hand thrown into water, deep soupy mud, against frozen ground, and into loose sand (employed test item only).

(3) Armed and hand thrown in the normal manner from a distance of 3 to 10 yards against a steel plate (some grenades impacted on the fuze end and others on the base end). This test simulated conditions that occur in a combat situation in a fortified area (employed test item only).

(4) Armed and hand thrown in the normal manner from a distance of 3 to 10 yards into a concrete emplacement to simulate a like combat situation. (Some grenades impacted on the fuze end and other on the base end.)

(5) Armed submerged in water, and the safety lever released by hand.

(6) Securely anchored in a vertical position to a wooden stake and covered by 1 inch of water and activated by removing the safety pin (employed test item only).

(7) Same as (6), above, except grenade was in a horizontal position.

(8) Armed, buried in soft mud, and the safety lever released.

(9) Rifle projected from distances of 50 to 60 yards to impact on wooden panels, a cinder block wall and a steel plate. This test simulated combat conditions in built up areas, firing at log bunkers, emplacements, gun crews protected by steel plates and concrete.

b. Data relating to fuze functioning in all tests were recorded.

3. RESULTS.

a. The following results were considered in determining the suitability of the test item.

(1) Submerged in muddy water, allowed to dry, hand thrown:

Item	Nr & Type Grenade	Fuze Burning Times (Sec)			Malfunctions
		Maximum	Minimum	Average	
Test	5 Inert	[illegible]	4.3	4.6	None
Control	5 Inert	4.9	4.2	4.6	None

(2) The test item only was hand-thrown into water, mud, frozen ground, and sand:

Nr Test Items	Type Grenade	Impact On	Fuze Burning Times (Sec)			Malfunctions
			Maximum	Minimum	Average	
5	HE	Water	4.7	4.4	4.5	None
5	HE	Mud	4.8	4.7	4.8	None
5	HE	Frozen Ground	4.8	4.3	4.6	None
5	HE	Sand	5.0	4.4	4.6	None

(3) The test item only was hand-thrown against steel plate:

Item	Impact	Nr & Type Grenade	Fuze Burning Times (Sec)			Malfunctions
			Maximum	Minimum	Average	
Test	Fuze end first	4 Inert 1 HE	5.1	4.3	4.6	2
	Base end first	6 HE				None

(4) Hand thrown against concrete:

Item	Impact	Nr & Type Grenade	Fuze Burning Time (Sec)			Malfunctions
			Maximum	Minimum	Average	
Test	Fuze end first	1 HE 4 Inert	4.5	4.0	4.3	3
	Base end first	2 HE 4 Inert				None
Control	Fuze end first	1 HE	4.6	4.4	4.5	None
	Base end first	2 HE				None

(5) Throughout the testing program, no evidonce of noise, smoke or spark was observed in the test and control items.

b. The following results were not considered in determining the suitability of the test item, as directed by reference 13, appendix IV.

(1) Covered with water, safety lever released by hand:

Item	Nr & Type Grenade	Fuze Burning Time (Sec)			Malfunctions
		Maximum	Minimum	Average	
Test	9 Inert 6 HE	4.7	4.3	4.5	6*
Control	5 Inert 6 HE	4 7	4.0	4.4	1

*Note: Four of the inert items did not detonate on the first try. They were then re-cocked and the grenades hand-thrown, whereupon they functioned normally.

(2) Buried in mud:

Item	Nr & Type Grenade	Fuze Burning Times (Sec)			Malfunctions
		Maximum	Minimum	Average	
Test	5 Inert 6 HE	5.2	4.6	4.8	None
Control	5 Inert 6 HE	4.9	4.3	4.6	None

(3) Rifle projected against wood:

Item	Nr & Type Grenade	Fuze Burning Times (Sec)			Malfunctions
		Maximum	Minimum	Average	
Test	5 Inert	6.1	4.7	5.0	None
Control	5 Inert	4.8	4.3	4.6	None

(4) Rifle projected against cinder blocks:

Item	Nr & Type Grenade	Fuze Burning Times (Sec)			Malfunctions
		Maximum	Minimum	Average	
Test	6 Inert 2 HE	4.8	4.3	4.5	4
Control	4 Inert 2 HE	5.3	4.4	4.6	1

(5) Rifle projected against steel plate:

Item	Nr & Type Grenade	Fuze Burning Times (Sec)			Malfunctions
		Maximum	Minimum	Average	
Test	7 Inert 1 HE	—	—	—	8
Control	4 Inert 1 HE	5.9	5.9	5.9	4

4. ANALYSIS.

a. Test and control fuzes function effectively when hand-thrown into water, mud, sand, and on various types of ground surfaces.

b. Test and control items function adequately when hand-thrown into or against hard surfaces, such as steel and concrete, if impact of the grenade is on the base end. However, if the fuze end (bouchon) strikes a hard surface first at close ranges (3 to 10 yards), the test item may fail to function. Of the five malfunctions occurring when the test item impacted fuze end first against steel and concrete, three occurred because the safety lever had not disengaged from the bouchon before impact; one, because the shoulders of the bouchon were squeezed together by the force of impact, preventing the striker from going forward; and for one, the reason for malfunction could not be determined. There is no significant difference between the functioning of the test and control items under these conditions.

c. When grenades are rifle-projected to impact on surfaces such as wood or timber, the test and control items function adequately. (Not considered in determining suitability.)

d. When grenades were rifle-projected against hard surfaces such as steel and concrete, both test and control items had high percentages of malfunctions. The cause of these malfunctions could not be determined. The safety levers had separated from the grenades in flight satisfactorily and examination revealed no breaks in the fuze bodies. The functioning of both test and control items is unsuitable when rifle-projected against steel and concrete. (Not considered in determining suitability.)

Test Nr 4, FRAGMENTATION AND LETHALITY.

1. PURPOSE.--To determine and compare the fragmentation pattern and lethality of grenades when detonated with the test and control items.

2. METHOD.

a. M26A1 grenades, fuzed with the test and control items, were individually detonated statically in the center of a circle composed of fragmentation panels made of commercially dressed 1 inch pine boards (3/4 inch by actual measurement) 6 feet high placed at a radius of 5 yards. Two grenades of each type were oriented with fuzes vertical and three of each type were oriented with fuzes horizontal and detonated as follows:

(1) At ground level.

(2) At ground level, plastered with mud.

(3) In pan of water at ground level, with water covering the grenade body.

b. M26A1 grenades, fuzed with the test and control items, were individually detonated statically in the common center of two semicircles composed of fragmentation panels made of commercially dressed 1 inch pine board (3/4 inch by actual measurement) 6 feet high. One semicircle had a radius of 10 yards. Directly opposite the open face of this semicircle, the second semicircle with a radius of 20 yards was set up so that the diameters of both semicircles fell on a common line and no portion of the semicircles overlapped. The grenades were oriented and detonated in the same manner as in 2(a) above, except that when oriented horizontally the base and fuze ends were pointing to the junctures of the two semicircles.

c. The fragmentation pattern of each grenade was recorded to show the number of penetrations, perforations, and 1 foot squares of panel area below the 3 foot level perforated by one or more fragments. Fragments which did not perforate the panels were not considered lethal.

3. RESULTS.

a. Ground Level.

FUZE VERTICAL (AVERAGES)

Item	Nr Gren	Distance to Target	Total Penetrations	Perforations			Percentage of Decrease in Perforations from 5, 10, and 20 Yards	Nr of 1 ft Sqs Below 3 ft Level Containing One or More Perforations
				Above 3 ft	Below 3 ft	Total		
Test	2	5 yd	1012	145	226	371		165
	2	10 yd	725	82	46	128	65%	Not Recorded
	2	20 yd	145	11	6	17	95%	Not Recorded
Control	2	5 yd	912	131	183	314		135
	2	10 yd	624	65	55	120	62%	Not Recorded
	2	20 yd	151	2	8	10	97%	Not Recorded

Note: Figures for grenades detonated within semicircles corrected to 360°.

FUZE HORIZONTAL (AVERAGES)

Item	Nr Gren	Distance to Target	Total Penetrations	Perforations			Percentage of Decrease in Perforations from 5, 10, and 20 Yards	Nr of 1 ft Sqs Below 3 ft Level Containing One or More Perforations
				Above 3 ft	Below 3 ft	Total		
Test	3	5 yd	946	77	124	201		95
	3	10 yd	663	45	55	100	50%	Not Recorded
	3	20 yd	159	11	8	19	91%	Not Recorded
Control	3	5 yd	1007	84	118	202		89
	3	10 yd	714	42	49	91	55%	Not Recorded
	3	20 yd	144	8	7	15	93%	Not Recorded

Note: Figures for grenades detonated within semicircles corrected to 360°.

b. When M26A1 grenades fuzed with test and control items were detonated at ground level in mud and water, penetrations were negligible at all ranges. At 5 yards from the target, the test fuzed grenade produced a total of four perforations and the control fuzed grenade produced one. At greater ranges (10-20 yards), neither type produced perforations.

c. When the M26A1 grenade was detonated at ground level with the test and control items oriented horizontally, there was an arc on the circle of panels of approximately 60° opposite the fuze end and approximately 70° opposite the base end of the grenades that received comparatively few penetrations and a negligible number of perforations.

d. Shown below for comparison purposes are fragmentation results obtained in this project and results reported on Project Nr 2580, Test of the M26 Hand Grenade fuzed with the M204A1 Fuze (ref 5, app IV). Grenades detonated statically at ground level, with fuze horizontal:

Comparison of average number perforations below 3 foot level on fragmentation panels 6 feet high:

Item	Range to Target	Perforations	% Increase
M26 w/M204A1 Fuze	5 yards	78.5	
M26A1 w/M204A2 Fuze	5 yards	118	50%
M26A1 w/T101E1 Fuze	5 yards	124	58%

4. ANALYSIS.

a. The analysis of the results of fragmentation when the grenade is positioned within a circular target area of 5 yard radius composed of fragmentation panels 6 feet high are as follows:

(1) There is no major difference in fragmentation effectiveness between test and control fuzed grenades when grenade is positioned with fuze vertical or when the fuze is horizontal. Both types give better fragmentation results when positioned with fuze vertical, as evidenced by a marked increase in both number of lethal fragments and number of square feet receiving lethal fragments on the target when positioned in this manner. In Test Nr 8, HAND THROWING, it was noted that the grenade will position itself after impact in a vertical or near vertical position approximately 2 per cent of the throws.

(2) Neither the test nor the control fuzed grenade has a near uniform fragmentation dispersion pattern when detonated in a horizontal position. Targets opposite the base and fuze ends of bot types receive an insignificant number of lethal fragments. The arc of the circle receiving few lethal fragments totals approximately 130°. This is the combined area opposite the fuze and base ends.

(3) The test and control fuzed grenades each show a substantial increase in lethal fragmentation over the limited standard M-26 grenade as evidenced by a 50-58% increase in lethal fragmentation below the 3 foot level at a 5 yard range.

(4) Both test and control fuzed grenades are equally ineffective when detonated in mud or water.

b. The analysis of the decline in the average of total number of lethal perforations by the test and control fuzed grenades, when positioned horizontally 5, 10 and 20 yards within a circular target area composed of fragmentation panels 6 feet high, is as follows:

(1) From 5 to 10 Yards.--The test fuzed grenade showed a decrease of 50 per cent in perforations and the control fuzed grenade showed a decrease of 55 per cent.

(2) Twenty Yards.--At this distance both test and control fuzed grenades became relatively ineffective. Both items gave a small number of lethal fragments spread over a relatively large area.

Test Nr 5, HOT AND COLD CHAMBER.

1. PURPOSE.--To determine and compare the effect of extreme temperatures on the test and control items.

2. METHOD.

a. M26A1 grenades fuzed with the test and control items were stored in a hot chamber at 125°F at maximum humidity for 72 hours. The grenades were examined for damage and then transported in an insulated container to the range and detonated by hand throwing.

b. M26A1 grenades fuzed with the test and control items were stored in a cold chamber at -30°F for 72 hours. The grenades were examined for damage and then transported in an insulated container to the range and detonated by hand throwing. (Subsequent to the conduct of this test USCONARC directed that items be conditioned at -25°F, ref 13, app IV.) All test and control items had been expended in original tests and none were available for retest of this phase.

3. RESULTS.--Shown below are the fuze burning times of test and control items following hot and cold chamber storage. All fuzed grenades functioned (Time in Seconds).

Time from Arming to Detonation	HOT CHAMBER		COLD CHAMBER	
	Test	Control	Test	Control
Maximum Time	5.0	4.7	5.6	5.4
Minimum Time	4.1	3.9	5.1	5.2
Average	4.4	4.2	5.3	5.3

4. ANALYSIS.

a. The test and control items function adequately with high order detonations after having been subjected to extreme highs of temperature and humidity.

b. The test and control items function adequately with high order detonations, but show an appreciable increase in the average burning time after having been subjected to an extreme low temperature. This increase in burning time for the test and control items is .7 second more than the maximum time (4.3 ± .3 seconds) stated in the military characteristics.

Test Nr 6, ADVERSE CONDITIONS.

1. PURPOSE.--To determine and compare the effects of adverse conditions upon the performance of the test and control items.

2. METHOD.

a. M26A1 grenades fuzed with the test and control items were removed from their containers and subjected to the following conditions:

(1) Five each type fuzed grenades were submerged in fresh water for three days.

(2) Five each type fuzed grenades were submerged in fresh water for three hours, then exposed to the elements for thirty days.

(3) Five each type fuzed grenades were submerged in salt water (1 pound of salt to 2½ gallons of water) for three days.

(4) Five each type fuzed grenades were submerged in salt water for three days and then exposed to the elements for three weeks.

b. After storage under adverse conditions listed in 2a, above, the fuzed grenades were inspected for damage and detonated by hand throwing.

3. RESULTS.

a. Visual examination of the test and control items after storage under adverse conditions revealed no damage.

b. The test and control items functioned adequately. However, when the grenades, which had been submerged in salt water for three days and placed in open storage for three weeks, were hand-thrown several malfunctions occurred. One each test and control item became unscrewed from the grenade upon impact with the ground. One test item became unscrewed from the grenade in flight. The safety lever of one control item did not come off immediately upon being thrown, but did come off upon impact with the ground.

HEADQUARTERS
UNITED STATES CONTINENTAL ARMY COMMAND
Fort Monroe, Virginia

ATDEV-3 471/48(C)(16 May 58) 16 May 1958

SUBJECT: Report of US Army Infantry Board, Project Nr 2751 (Temperate), Service Test of Fuze, Grenade, Hand, T1011E1 (DA Project Nr 505-04-001) (U)

TO: Chief of Research and Development
Department of the Army
Washington 25, DC

1. (UNCLASSIFIED) Inclosed is a copy of Report of US Army Infantry Board, Project Nr 2751 (Temperate), 19 March 1958, subject: "Service Test of Fuze, Grenade, Hand, T1011E1 (DA Project 505-04-001 (U))."

2. (UNCLASSIFIED) Commanding General, United States Continental Army Command, concurs in the conclusions of President, US Army Infantry Board, as stated in paragraph 6 and approves the recommendations in paragraph 7, inclosed report, as restated below.

3. (CONFIDENTIAL) It is recommended that:

a. The Fuze, Grenade, Hand, T1011E1, be adopted for Army use with the Grenade, Hand, Fragmentation, M26A1 (Modified), and be type classified as standard type, Modernization Code A.

b. The Fuze, Grenade, Hand, T1011E1, with Grenade, Hand, M26A1 (Modified), be further modified to correct the deficiencies cited in appendix II, inclosed report.

c. President, US Army Infantry Board, be furnished 100 each of the initial production lot of the modified Fuze, Grenade, Hand, T1011E1, with Grenade, Hand, Fragmentation, M26A1 (Modified), for confirmatory test.

22 1958

584 6503

4. (UNCLASSIFIED) It is requested that CG, USCONARC, ATTN: Materiel Developments, be notified of action taken.

FOR THE COMMANDER:

Leonard S. Lee

LEONARD S. LEE
Major, AGC
Asst Adjutant General

1 Incl
Rept of USA Inf Bd, Proj Nr 2751 (Temperate), 19 Mar 58, w/app I-IV

Copies furnished:
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Comd, ASTIA

c. Shown below are the burning times of test and control items after storage under adverse conditions.

Item		3 Days in Water	3 Hrs in Water 30 Days Storage	3 Days in Salt Water	3 Days in Salt Water 3 Wks Storage
Test	Maximum	4.5 sec	4.8 sec	4.8 sec	5.0 sec
	Minimum	4.2 sec	4.3 sec	4.4 sec	4.7 sec
	Average	4.4 sec	4.4 sec	4.6 sec	4.9 sec
Control	Maximum	4.4 sec	4.4 sec	4.7 sec	5.1 sec
	Minimum	4.1 sec	4.0 sec	4.2 sec	4.8 sec
	Average	4.3 sec	4.3 sec	4.4 sec	4.9 sec

4. ANALYSIS.

a. Test and control items function adequately after being subjected to storage under adverse conditions.

b. The lack of a sealing compound between the fuze and the grenade, as noted in Test Nr 1, PHYSICAL CHARACTERISTICS, may permit the test and control items to become unscrewed from the grenade in some instances when hand thrown after storage under adverse conditions. This may adversely affect functioning.

c. The increase in burning time of the test and control items following immersion in salt water and open storage for three weeks, might be attributable to the freezing temperatures prevailing (18° - 32°F) during this test.

*Test Nr 7, RIFLE PROJECTION.

1. PURPOSE.--To determine and compare the performance of the test and control fuzed grenades when projected from a rifle.

2. METHOD.

a. M26A1 grenades fuzed with test and control items were projected from an M-1 rifle in a machine rest, utilizing the M7A3 rifle grenade launcher, M1A2 grenade launcher adapter and M3 rifle grenade cartridges. The rifle was laid at various elevations from 350 to 600 mils to determine the maximum range attainable.

b. M26A1 grenades fuzed with test and control items were rifle-projected using the same system as described in a, above, so as to impact against a tank hull, a concrete block, and the ground at ranges varying from 75 to 150 yards to determine stability in flight and reliability of arming.

c. The stability in flight and reliability of arming of the test and control items when rifle-launched was observed and recorded.

d. Fuze burning times were determined from time of projection to detonation.

3. RESULTS.

a. Rifle Projected to Obtain Maximum Range.

AVERAGE RANGES ATTAINED

Items	Nr & Type Grenade	Elevation (Mils)	Range (Yards)	Fuze Burning Time (Sec)			Malfunctions
				Max	Min	Avg	
Test	6 Inert 5 HE	500	135	5.2	4.5	4.8	None
		550	150				
		600	**Air-burst				
Control	5 HE	500	140	5.0	4.5	4.7	None
		550	148				
		600	**Air-burst				

* Subsequent to conduct of this test, USCONARC directed that rifle projection tests not be conducted (ref 13, app IV). The results of this test were not considered in determining the suitability of the test item.

**Airbursts were approximately 150-175 yards from projection point and varied approximately 5 to 50 feet in height above the ground.

b. Rifle Projected Against Various Surfaces.

Item	Nr & Type Grenade	Impact On	Fuze Burning Time (Seconds)	Malfunctions
Test	2 HE 2 Inert	Steel	4.8	2*
	3 HE 2 Inert	Concrete	5.6	3*
	4 HE 3 Inert	Ground	4.7	0
Control	2 HE 1 Inert	Steel	5.0	2*
	1 HE 2 Inert	Concrete	5.4	1*
	5 HE	Ground	4.8	0

*Note: In all instances primers had been struck by the striker prior to impact on the steel or concrete.

c. The majority of the grenades and adapters, when rifle projected as in a and b, above, were stable in flight. There were a few instances in which some wobbling of the adapter occurred. However, there were no instances of tumbling observed.

4. ANALYSIS.

a. The maximum range attained with M26A1 grenades fuzed with both test and control items when rifle projected was approximately 150 yards. Low airbursts were difficult to attain due to variation in fuze burning times of both test and control items. Test and control items function adequately when impact of the fuzed grenade is with the ground.

b. The functioning of M26A1 grenades fuzed with test and control items when rifle projected against steel and concrete is unsatisfactory. Fifty-five per cent (55%) of the test and fifty per cent (50%) of the control items projected in this manner failed to function.

Test Nr 8, HAND THROWING.

1. PURPOSE.--To determine and compare the performance of the M26A1 grenade fuzed with the test and control items when thrown by hand.

2. METHOD.

a. Ten men of varying degrees of physical capability threw ten each inert grenades fuzed with test and control items from the standing position to obtain maximum range.

b. Ten men of varying degrees of physical capability threw ten each inert grenades fuzed with test and control items at a bull's-eye type horizontal target from the prone position at a range of 25 yards to ascertain accuracy. The point of impact of all throws was measured from the center of the target. This test was repeated from the standing position.

c. Test in b, above, was repeated at a range of 40 yards.

3. RESULTS.

a. There is no difference in the distance nor accuracy attained with the M26A1 grenade fuzed with the test and control items when hand thrown.

b. The average maximum distance for test and control fuzed grenades was 143 feet.

c. Average throwing error (test and control fuzed grenade).

Distance (Yards)	Position of Thrower	Error (feet)
25	Prone	5.0
25	Standing	3.4
40	Prone	12.6
40	Standing	7.9

Test Nr 9, SUITABILITY FOR PARACHUTE DELIVERY.

1. PURPOSE.--To determine and compare the suitability of the test item for parachute delivery.

2. METHOD.

a. Five M26A1 grenades fuzed with the test item were packed in a standard shipping box so that they would impact on the ground with the test item up. This box also contained sufficient sand in individual grenade containers to cause the box to be equivalent in weight to a box of 25 grenades. This box was included with enough sand filled boxes to make a bundle having a total weight of 300 pounds. The bundle was dropped from a C-119 cargo type aircraft flying at a speed of 150 mph at an altitude of 1000 feet onto an unimproved drop zone, utilizing a G-1A cargo type parachute.

b. The same test as 2a, above, was repeated but grenades were packed so that items would impact on the ground with the test item down in the direction of impact.

c. The same test as 2a, above, was repeated but grenades were packed so that items would impact on the ground with the test item horizontal to the direction of impact.

d. The three tests listed in 2a, b, and c, above were repeated with the grenades fuzed with the control item.

e. The three tests in 2a, b, c, and d above, were repeated but the cargo parachute was rigged to malfunction in each case.

f. Upon completion of the cargo drops, the test and control items were inspected for damage and serviceability by ordnance personnel.

3. RESULTS.

a. In two instances when delivered by malfunctioning parachute the handles of the grenades were bent in varying degrees but the items were not rendered unserviceable. One grenade was thrown from its containers several feet from the point of impact. Upon being recovered and inspected it was found to be serviceable. Two grenades were slightly flattened on one side at their widest diameter when delivered by malfunctioning parachute. All grenades were determined visually to be safe for handling and were transported to the grenade range and detonated. All test and control fuzed grenades detonated with high order detonations (app III-3).

b. Effect of impact upon burning time of the test and control item (time in seconds).

Position of Fuze to Direction of Impact	TEST						CONTROL					
	FUNCTIONING PARACHUTE			MALFUNCTIONING PARACHUTE			FUNCTIONING PARACHUTE			MALFUNCTIONING PARACHUTE		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Fuze Horizontal	5.0	4.3	4.6	4.8	4.2	4.4	5.0	4.4	4.7	4.8	4.2	4.5
Fuze Up	5.0	4.3	4.7	4.9	4.1	4.6	4.9	4.0	4.6	4.9	4.0	4.6
Fuze Down	5.0	4.4	4.8	5.0	4.4	4.8	4.9	4.1	4.6	5.0	4.6	4.8

4. ANALYSIS.

a. The test and control items are suitable for aerial delivery by functioning cargo parachute.

b. When test and control items are delivered by malfunctioning parachute, damage may result to individual grenades. A thorough examination should be made of each individual grenade while it is still in its container to determine if any damage has occurred which would render it unsafe.

c. The average time from arming to detonation of test and control items delivered by both functioning and malfunctioning parachute is increased in some instances. This increase in fuze burning time appears to depend upon the degree of shock to which each individual bundle is subjected.

Test Nr 10, RELIABILITY.

1. PURPOSE.--To determine and compare the reliability of the test and control items.

2. METHOD.--All the data recorded, when grenades were detonated statically and by hand throwing, were studied, analyzed and compared to determine the reliability of the test and control items.

3. RESULTS.--Shown below are the results of all detonations of M26A1 grenades fuzed with the test and control items under various conditions.

a. Not subjected to abnormal conditions:

Item	Nr	Under 3.0 Sec	3.0-3.9 Sec	4.0-4.6 Sec	4.7-5.0 Sec	5.1-6.0 Sec	Max Time Variation (Sec)	Avg Time (Sec)	Duds
Test (Percentage of total)	57	0	2(3%)	38(67%)	11(19%)	1(2%)	1.2	4.6	5(9%)*
Control (Percentage of total)	34	0	5(15%)	25(73%)	4(12%)	0	1.5	4.3	0

*Note: Duds occurred when grenades fuzed with test item were hand-thrown against steel and concrete and impacted with the fuze end first.

b. Subjected to abnormal conditions (Hot and Cold Chamber, adverse conditions, parachute delivery)

Item	Nr	Under 3.0 Sec	3.0-3.9 Sec	4.0-4.6 Sec	4.7-5.0 Sec	5.1-6.0 Sec	Max Time Variation (Sec)	Avg Time (Sec)	Duds
Test (Percentage of Total)	90	0	0	42(47%)	43(48%)	5(5%)	1.4	4.6	2*
Control (Percentage of total)	60	0	1(2%)	32(53%)	22(37%)	5(8%)	1.5	4.6	1*

*Note: The test and control items functioned normally, but when hand-thrown they became unscrewed from the grenades in flight or upon impact with the ground due to lack of sealant between the fuze and the grenade. These particular items had been immersed in salt water and placed in open storage for three weeks prior to detonation.

4. ANALYSIS.

a. No low order detonation occurred during the conduct of this project. Ninety-seven per cent (97%) of the test and one hundred per cent (100%) of the control fuzes functioned reliably under all conditions. There is no significant difference between the reliability of the test and control items.

b. Neither the test nor the control items fully meet the military characteristics of having a 4.3 ± .3 second fuze burning time between activation and detonation. However, ninety-two per cent (92%) of the test items and eighty-nine per cent (89%) of the control items had a burning time of 4.0-5.0 seconds under all conditions. The control item showed a slightly greater maximum time variation in fuze burning time than did the test item.

Test Nr 11. COMPARISON WITH MILITARY CHARACTERISTICS.

1. PURPOSE.--To determine the extent to which the test item meets the approved military characteristics for fragmentation hand grenade fuzes.

2. METHOD.--The results of all tests were analyzed to determine the degree to which the test item meets the approved military characteristics.

3. RESULTS.

Military Characteristics	Discussion
* * * * * E X T R A C T (ref 3, app IV)	
4. ESSENTIAL CHARACTERISTICS.	
* * * * * * * *	
(e) Military characteristics of each country will determine type of fuze to be used.	
To permit interchange of fuzes, the fuze well and threads shall be common to all three countries.	Although the threads of the test item will fit the M26A1 grenade, the fuze well of the M26A1 grenade, designed to accept the M204A2 fuze, is too small in diameter to accept the detonator case of the test item (Test Nr 1).
The time element to be used by all three countries shall be 4.3 seconds plus or minus 0.3 seconds after projection.	Requirement met to an acceptable degree. The degree to which this is met depends upon adoption action by the Tripartite countries.
The operation of the fuze shall be noiseless, smokeless and sparkless.	Requirement met (Test Nr 3).
* * * * * * * *	
5. DESIRABLE CHARACTERISTICS.	
* * * * * * * *	
(b) If a handle is provided it shall not contain the fuze.	M26A1 Grenade has no handle.
* * * * * * * *	
* * * * * E X T R A C T (ref 2, app IV)	
* * * * * * * *	
e. Fuze: The grenade shall be provided with a fuze containing time and impact elements.	Requirement not fully met. The fuze contains a time element only.
* * * * * * * *	

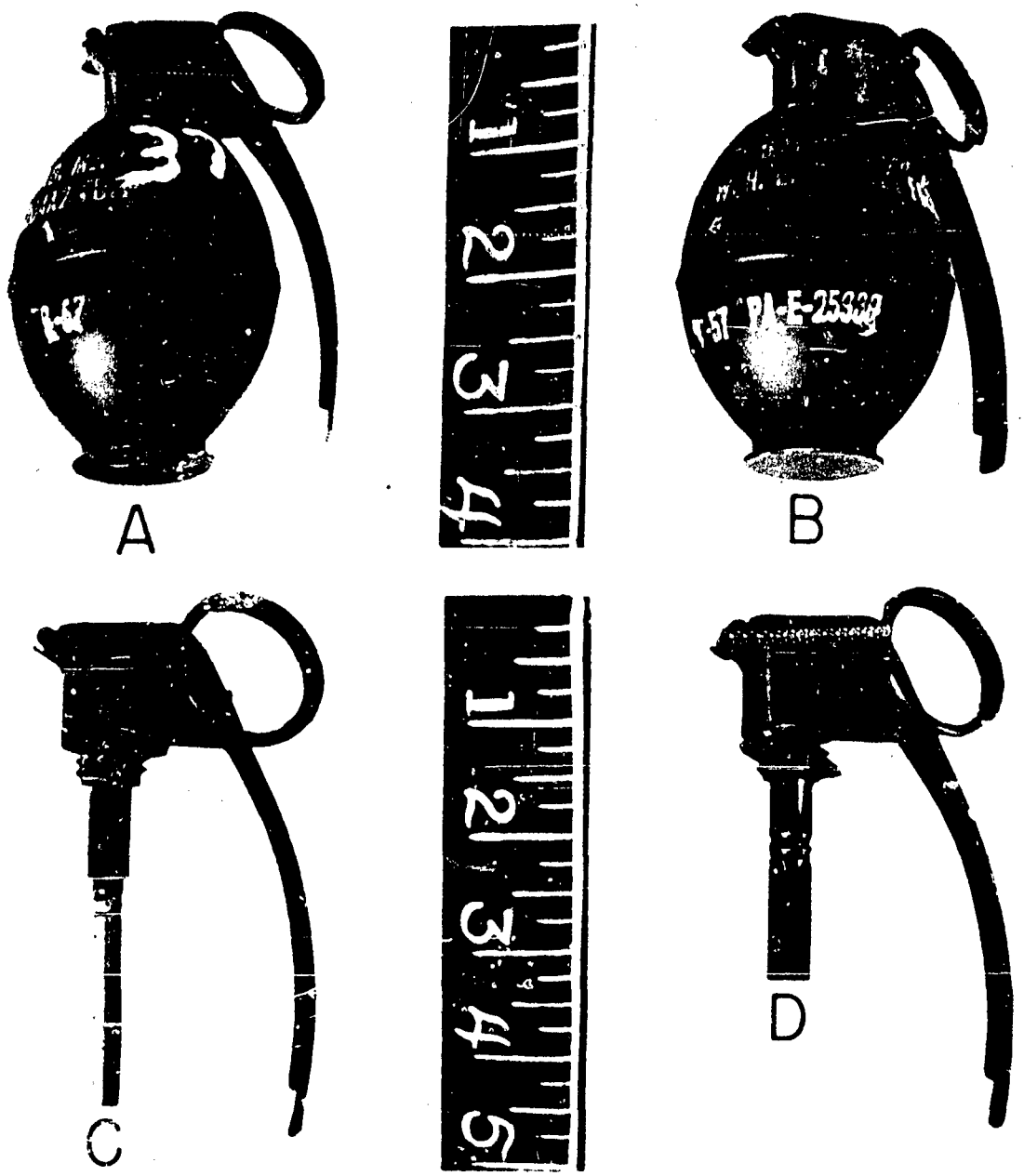
(2) Impact Element:	
(a) The grenade shall detonate by action of the impact element during the interval 1 second to 4.3 seconds plus or minus 0.3 seconds after arming. If upon impact an instantaneous detonation reduces lethality of the grenade, a fractional second to position the grenade for maximum lethality will be desirable.	Item has no impact element.
(b) A blow equivalent to dropping the grenade 18" on concrete shall be required to cause impact element of the fuze to operate, after arming.	Item has no impact element.
(3) Time Element:	
The grenade shall detonate by action of the time element 4.3 seconds plus or minus 0.3 seconds after arming.	Requirement not fully met. Times of detonation after arming in Test Nr 5, HOT AND COLD CHAMBER (after cold storage and in Test Nr 6), ADVERSE CONDITIONS (after open storage for 3 weeks following immersion in salt water), were .7 and .3 seconds, respectively, greater than the maximum time of 4.6 seconds. However, this is considered acceptable performance.

APPENDIX II - DEFICIENCIES AND SUGGESTED MODIFICATIONS

Report of Project Nr 2751

The deficiencies listed in this appendix are minor deficiencies, the correction of which will increase the desirability of the item, but which need not be corrected to make this item suitable for Army use.

	Minor Deficiency	Results	Suggested Modification
1.	Fuze burning times between 4.6 and 5.3 seconds. (Tests Nr 5 and 6, app I.)	Fails to meet the military characteristics of 4.3 seconds, ± .3 seconds, fuze burning time.	Correct.
2.	T1011E1 fuzes were assembled in M26A1 grenades without sealing compound between fuze and grenade and became loose when stored under adverse conditions (Test Nr 6, app I).	Disassembly of fuze from grenade when hand thrown.	Correct.



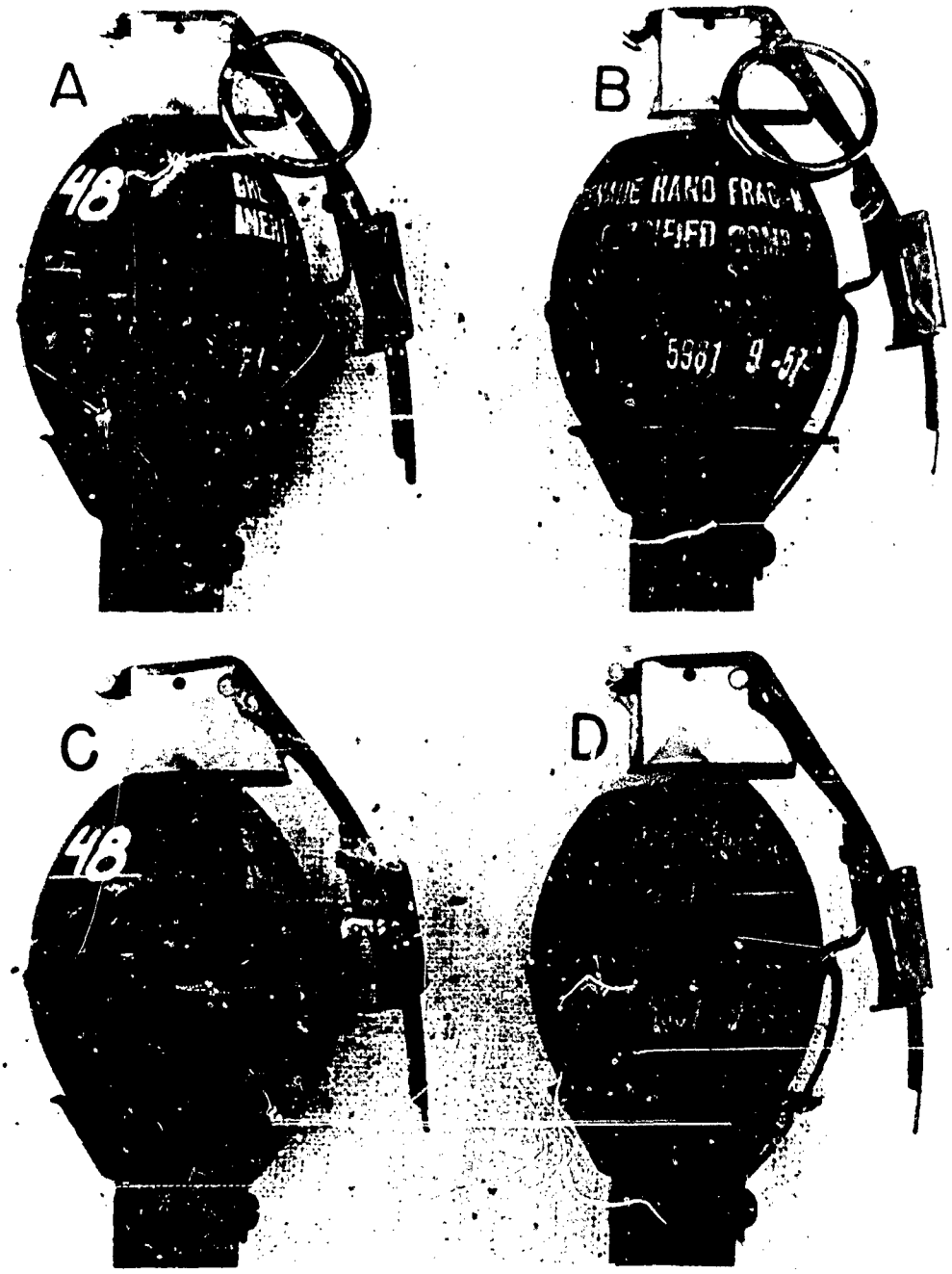
UNITED STATES ARMY INFANTRY BOARD

FORT BENNING, GEORGIA

PROJECT NR	DATE	NEGATIVE NR
2751	16 Jan 68	09-166-50/AJ-88

A - Grenade, Hand, M26A1, with Fuze, M204A2 (Control)
B - Grenade, Hand, M26A1, with Fuze, T1011E1 (Test)
C - Fuze, Grenade, Hand, M204A2 (Control)
D - Fuze, Grenade, Hand, T1011E1 (Test)

App III-1



UNITED STATES ARMY INFANTRY BOARD
FORT BENNING, GEORGIA

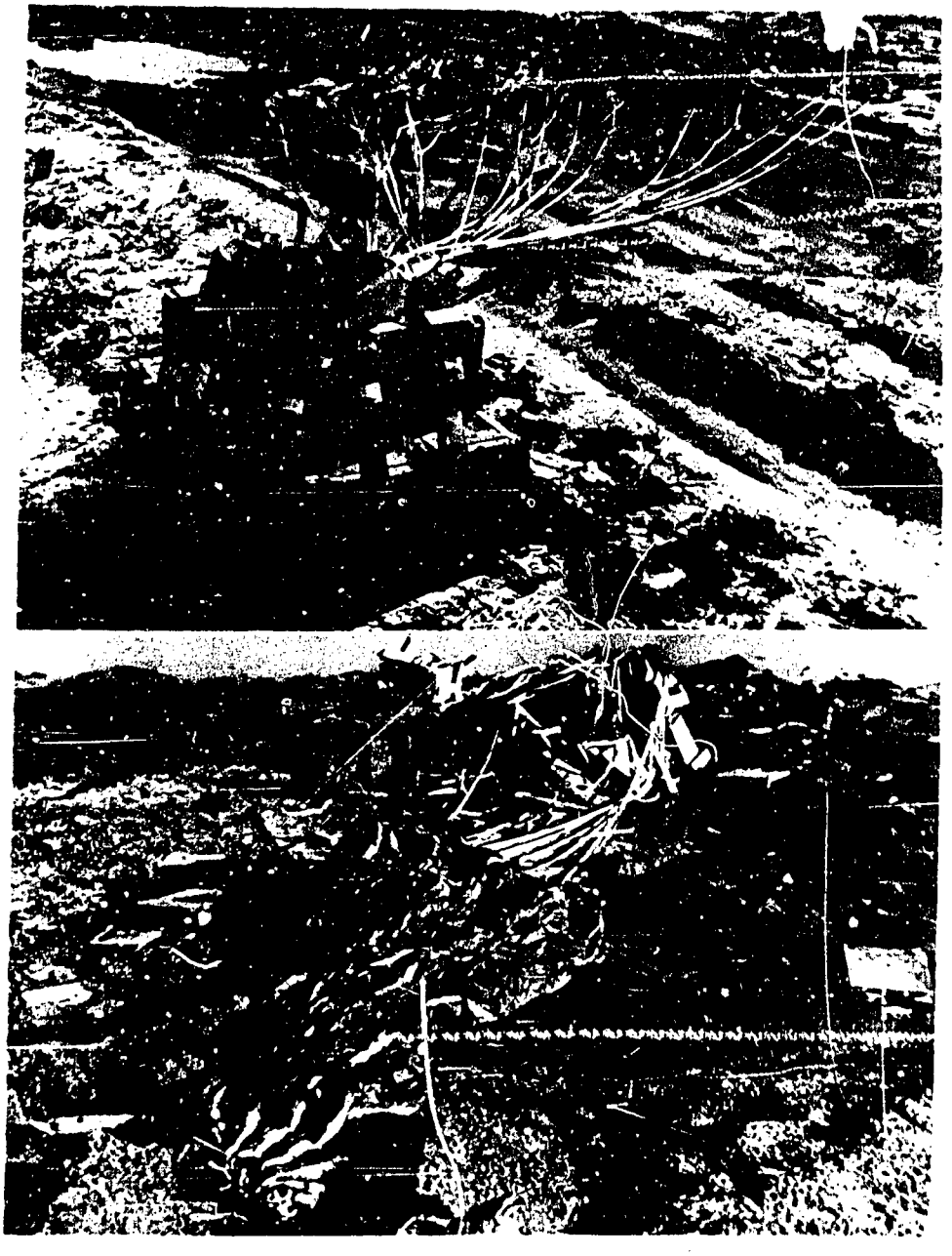
PROJECT NR	DATE	NEGATIVE NR
2751	16 Jan 58	09-166-51/AJ-58

A - M26A1 Grenade with T101IE1 Fuze properly seated in M1A2 Grenade Adapter, Safety Pin In

B - M26A1 Grenade with M204A2 Fuze properly seated in M1A2 Grenade Adapter, Safety Pin In

C - M26A1 Grenade with T101IE1 Fuze in M1A2 Adapter, Safety Pin Removed

D - M26A1 Grenade with M204A2 Fuze in M1A2 Adapter, Safety Pin Removed



UNITED STATES ARMY INFANTRY BOARD
FORT BENNING, GEORGIA

PROJECT NR	DATE	NEGATIVE NR
2751	16 Jan 58	09-166-52/AJ-58

Top: Typical Aerial Delivery Container with Functioning Parachute.
Bottom: Typical Aerial Delivery Container with Malfunctioning Parachute.

[redacted]

APPENDIX IV - REFERENCES

Report of Project Nr 2751

1. FM 23-30, w/changes 1-4, DA, 14 Apr 49, Hand and Rifle Grenades.

2. Report of Project Nr 2481, AFF Bd Nr 3, 21 Jul [illegible], Military Characteristics for Fragmentation Hand Grenade.

3. OCM Item 35169, OCOFORD, 30 Sep 53, subject: "FRAGMENTATION HAND GRENADE - MILITARY CHARACTERISTICS."

4. OCM Item 35231, OCOFORD, 10 Feb 54, subject: "FUZES, GRENADE, HAND, M204A2, M206A2, AND PRACTICE, M205A2 - Classification as Standard Type: FUZES, GRENADE, HAND, M204A1, M206A1, AND PRACTICE, M205A1 - Classification as Limited Standard Type."

5. Report of Project Nr 2588, Bd Nr 3, OCAFF, 12 Feb 54, Check Test of M26 Fragmentation Hand Grenade.

6. Paragraph 277, Army Equipment Development Guide, DA, 3 May 54.

7. Ltr, ATBC 471.6 (P-2601) (Arctic), Bd Nr 3, OCAFF, 24 Sep 54, Report of Project Nr 2601 (Arctic), Test of Grenade, Hand, Fragmentation, M26 (DA Project Nr 5-04-11-004).

8. Technical Information Report 8-5-1A1, OCOFORD, Aug 55, Development of Hand Grenade Fuze, T101lE1.

9. Technical Information Report 8-5, OCOFORD, Aug 55, Development of Fuzes for Grenades.

10. Report of Project Nr 2683, Bd Nr 3, CONARC, 27 Nov 55, Test of Production Fuze, Grenade, M204A2.

11. 2d Ind, ORDBB-DC3, Ord Corps, Picatinny Arsenal, 9 Jul 57, to Ltr, TP470, Picatinny Arsenal to Diamond Ord Fuze Lab, 5 Jun 57, subject: "Request for Notes on Materiel and Drawings of Ordnance Small Arms Items."

12. Notes on Development Type Materiel Nr 174, Fuze, Grenade, Hand, T101lE1, Picatinny Arsenal, Nov 1957.

13. Comment Nr 2, MD, USCONARC, 4 Dec 57, to DF, ATBC 471.82 (P-2751), this Board, 27 Nov 57, subject: "Plan of Test of Project Nr 2751, Service Test of Fuze, Grenade, Hand, T101lE1."

[redacted]

This Project Executed

by

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UNITED STATES ARMY INFANTRY BOARD

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